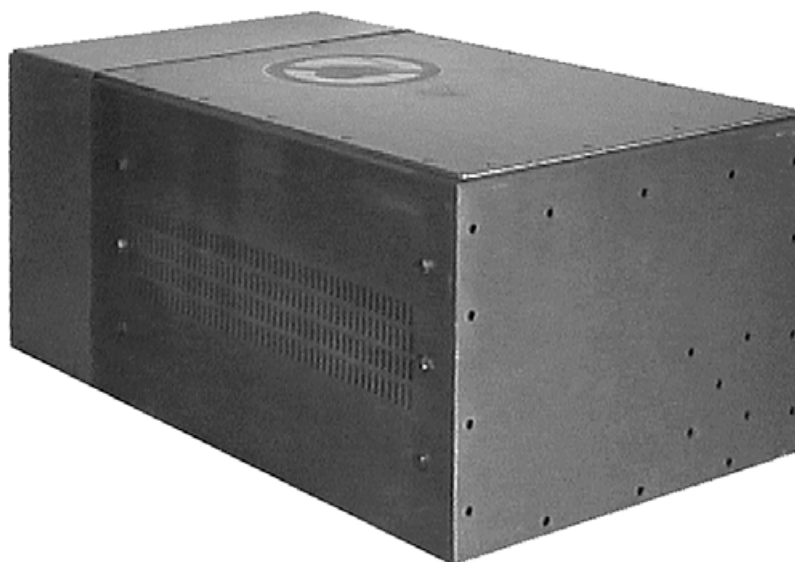


Operating Instructions Matchbox PFM 1500 A



Notice!

This operating manual is required for the safe operation of the PFM 1500 A Matchboxes. Therefore, you should keep the operating manual close to the unit.

Who are these operating instructions for?

This manual is intended for all persons who are working with and on the PFM 1500 A Matchboxes, and especially for the operating personnel.

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This manual contains the most precise description of the product possible. However, this does not guarantee particular features or application results. We are always grateful for criticism or hints regarding imperfections, and suggestions for possible improvements.

Unless otherwise stated, the relevant State of Engineering is that at the time of combined delivery of the product and the manual by HÜTTINGER Elektronik GmbH & Co. KG. The product is subject to technical changes without prior notice. Previous manuals are no longer valid.

Do you have any questions? Or problems with installation and operation? - Call us! We will be glad to help you.

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This operating manual concerns the devices of the PFM 1500 A line of products listed below, as well as devices with the same code for the wiring diagram (B 82-...), even though their Item number is not listed here.

461490	(B 82-0176-00.S)
461746	(B 82-0221-00.S)
461765	(B 82-0226-00.S)
910492	(B 82-0240-00.S)
941164	(B 82-0253-00.S)
943440	(B 82-0254-00.S)
944455	(B 82-0258-00.S)
952756	(B 82-0259-00.S)
964526	(B 82-0261-00.S)
967318	(B 82-0176-00.S)
1212719	(B 82-0268-00.S)

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1 GENERAL INFORMATION

Chapter Outline:

Who is this chapter directed at?

This chapter is intended for all persons who install, operate, and maintain PFM 1500 A Matchboxes on the basis of this operating manual.

Chapter contents

This chapter contains the principal details of the product and the operating manual.

1.1 GENERAL DETAILS OF THE PRODUCT

The present operating manual applies to the following units:

- PFM 1500 A Matchboxes

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1.2 WARRANTY

The duration of the warranty is specified in the **order confirmation** and in the **general terms and conditions of sale and delivery of HÜTTINGER Elektronik GmbH + Co. KG**.

Damage caused by improper use or unauthorized modification of the device does not constitute grounds for a warranty claim.

1.3

STRUCTURE OF THE DOCUMENTATION

GENERAL

There are two types of accompanying documents for Hüttinger products:

- Operating manual
 - The operating manual provides all necessary details for the installation, operation and maintenance of the respective systems.
- Technical documents regarding the unit
 - The technical documents regarding the unit provide detailed plans, drawings and lists for the unit. This information is not meant for operating personnel. Service, maintenance and repair guided by these documents must be carried out by specially trained skilled personnel only.

This document is the **operating manual**.

STRUCTURE OF THE OPERATING MANUAL

The present operating manual consists of eight chapters which contain all necessary information for the operation of the system:

- Chapter 1: "STRUCTURE OF THE DOCUMENT"
- Chapter 2: "SAFETY"
- Chapter 3: "DESCRIPTION, TECHNOLOGY"
- Chapter 4: "VERSIONS, ACCESSORIES"
- Chapter 5: "INSTALLATION"
- Chapter 6: "OPERATION, CONTROL"
- Chapter 7: "MAINTENANCE"
- Chapter 8: "INTERFACES"

STRUCTURE OF THE INDIVIDUAL PAGES

Header

A product symbol is located at the top outside corner of the page so that it is straight-forward to recognize the product to which the operating manual applies.

Footer

The footer contains information about the actual chapter:

- chapter number and name,

- document name

The current chapter is indicated by a pictograph above the page number which contains the chapter number and corresponding symbol.

EXPLANATION OF PICTOGRAMS AND SYMBOLS



Danger !

This sign warns of possible personal injury. Serious and even fatal injuries could result if this sign is not heeded.



Life Threatening Voltage !

This sign warns of danger from electrical voltage. If not heeded, electrical shocks and their known, even fatal, consequences could result.



Warning !

This sign warns of dangers for the product. Damage and even complete destruction of the product and adjoining parts can result if this sign is not heeded.



Warning: Electromagnetic fields !

This symbol warns of electromagnetic fields.



Danger: High frequency !

These signs warn of danger from high frequency radiation. Persons with pacemakers or implants may not enter areas where this sign is posted as pacemaker operation can be disturbed by the presence of high frequency radiation and implants can heat-up.



Notice !

This sign draws attention to important information.



Symbol of work step instructions

This symbol calls your attention to tasks which are to be carried out.

1.4 TECHNICAL EXPRESSIONS AND ABBREVIATIONS

DESCRIPTION OF ABBREVIATIONS USED

C_L	nominal/actual value of the load capacitor
C_T	nominal/actual value of the tuning capacitor
Φ	phase angle of the load power vector
P_I	RF power (incident power)
P_R	reflected RF power
T_d	dew point temperature
T_W	cooling water temperature
$U_{HF} \text{ Peak}$	RF peak voltage at the output of the matchbox
Z	size of the load power vector

EXPLANATION OF TERMS USED

<i>DC bias voltage</i>	DC voltage, created by spontaneous gas discharge in plasma processes
<i>Matchbox</i>	adjustable tuning network for the optimum adjustment of the load to the RF generator
<i>Controller</i>	controlling device for the matchbox, allows for manual and automatic tuning of the matchbox
<i>FOC</i>	fiber-optic cable
<i>Reflectometer</i>	device for measuring the forward and reflected RF power
<i>Magnitude / phase detector</i>	device for measuring the differential magnitude and the phase of the transmitted RF power at the input of the matchbox
<i>Reactive current compensation</i>	rough adjustment of the matchbox for different loads can be carried out using an additional coil in the tuning circuit with a variable tap. This improves the tuning performance.

2 SAFETY

Chapter Outline:

Who is this chapter directed at?

This chapter is intended for all persons who install, operate, and maintain PFM 1500 A Matchboxes on the basis of this operating manual.

Chapter contents

The chapter contains the principal details for the safe operation of the product.

2.1 INTENDED USE



Danger!

The protection of operating personnel and the device is not guaranteed if the device is not operated in compliance with its intended use.



The matchbox may only be operated by qualified personnel in compliance with these operating instructions.

FUNCTIONS AND OPERATION OF THE EQUIPMENT

Tuning network with variable impedance matching

The matchbox automatically compensates for RF impedance-varying loads. It provides the source RF generator with a regulated, impedance matched 50 Ω load.

The functions of the matchbox can be controlled either through the RF generator (in "internal" operating mode) or by using the optional PFC controller (in "internal" operating mode).

Full information about this can be found in chapter 3: "Description, technology".

INTENDED USE

The PFM series matchbox was conceived as an impedance matching device which can be directly mounted to systems producing varying RF loads.

Unauthorized operation

The PFC controller is suited to the operation of PFM Matchboxes plus accessories (e.g. RF selectors) and data transfer for customer remote control systems.

The PFM matchbox and the PFC controller may be used only within the scope of their intended use.

2.2

GENERAL WARNING NOTICES

DANGER DURING OPERATION OF THE MATCHBOX



Danger: high frequency!

Alternating electromagnetic fields can have an unwanted, damaging effect on active and passive health aids (pacemakers, implants ...). Persons with active and passive health aids must stay outside of areas affected by the matchbox.

Due to the intensity of the electromagnetic field, magnetic materials can heat up and possibly melt.



Use only nonmagnetic materials (brass, stainless steel, copper) for mounting the matchbox and for attaching other devices to it.



Place the warning signs included with the shipment at all entrances to the room where the matchbox is operating.

DANGERS DUE TO HIGH VOLTAGES



Life-threatening voltages!

The matchbox provides impedance matching for RF generators. The high voltages present at the RF output of the RF generator and matchbox during undisturbed operation are absolutely life-threatening.



Life-threatening voltages!

Even after switching off and disconnecting the mains, residual voltages can be present in the matchbox.



Never open the matchbox or the PFC controller. The device may only be opened by properly instructed qualified personnel after being disconnected from the mains.



Before opening the RF unit, disconnect the PFM matchbox from the RF generator, any application and further supply units which may be connected.



Danger!

In order to provide protection against electromagnetic fields and electric shock, the connection between matchbox and application must be made according to the instructions given in chapter 5: "Installation". Bringing a high-frequency system into operation whose application has not been connected as described above can lead to the following dangers:

- Electrical shock and / or burns when touching uncovered parts.
- Exposure of persons to electromagnetic fields.
- Faulty functioning or damage to other devices due to electromagnetic fields.

Contact HÜTTINGER for any questions concerning use with your application.

2.3

SAFETY DEVICES

MONITORING AND SAFETY DEVICES



Warning!

No interlocking devices are provided with the PFM Matchbox. It is the operator's responsibility to ensure that the input RF power, as well as the output RF current and voltage do not exceed the maximum allowable values (see document "Technical Specification") and that the required cooling water amount for the device is maintained at all times during operation. Failure to operate the device as described in these operating instructions may result in damage to or destruction of the device.

**Notice!**

As the operator, you are responsible for the safe operation of the PFM matchbox. It is your responsibility to know the applicable legal regulations and to apply them.

2.4

EMERGENCY MEASURES



In an emergency, carry out the following steps in the given order:

1. Switch off the external mains separation device for the RF generator as well as for matchbox and controller.
2. Turn off the cooling water supply for the generator and matchbox.
3. Put out any fires with a suitable extinguisher.

**Life-threatening voltages!**

Due to the high voltages, never extinguish the fire with water.

3 DESCRIPTION, TECHNOLOGY

Chapter Outline:

Who is this chapter directed at?

This chapter is intended for all persons who install, operate, and maintain PFM 1500 A Matchboxes on the basis of this operating manual.

Chapter contents

The chapter contains information about the functionality and technology of the PFM 1500 A Matchboxes, their use, fields of application, and technical data.

3.1 CLASSIFICATION ACCORDING TO EN 55011

The EN 55011 standard groups ISM devices (industrial, scientific and medical high-frequency devices) into various groups and classes.

The PFM 1500 A Matchboxes are devices of **Group 2 / Class A**.

Group 2 includes all ISM devices, where HF energy is purposely generated and / or used as electromagnetic radiation for the treatment of material.

Devices of Class A are intended for operation in an industrial environment. The electromagnetic compatibility in other environments (residential areas) may not be guaranteed due to the conductor-bound interference factors that occur.

3.2 DESCRIPTION OF FUNCTIONS

PLASMA PROCESS REQUIREMENTS

A plasma process can be regarded electrically as a parallel connection of a variable capacitor with a variable resistor, hence it is a variable complex load.

The RF power is transmitted most efficiently to a non-reactive load: HÜTTINGER RF generators are designed for 50 Ω loads. A Matchbox (tuning network) directly connected to the application is used to transform the complex load of the plasma process to a stable 50 Ω resistive load.

At its input, the Matchbox measures magnitude and phase of the RF power transmitted to the Matchbox + plasma chamber combination, and, by means of an internal microcontroller, provides a stable "optimum load".

THE MATCHBOX

The PFM 1500 A Matchbox is an active tuning network which ensures "optimum loading" of the RF power source under variable load conditions. The Matchbox can be controlled either via fiber optic cables (PFG RF or PFC device series) or via the A/D interface. The optional PFC Controller can be connected via optical data interfaces for controlling up to ten Matchboxes and as a data source for a process control system. Contrary to many other systems, the PFM 1500 A Matchbox measures the process-related DC bias voltage. This value is transmitted via the interfaces and can be displayed or used as control parameter.

Further details about Matchbox operation with the PFC Controller can be found in Chapter 6 of the "PFC Controller" operating instructions.

OPERATION MODES

The PFM 1500 A Matchbox can be operated in two modes:

External mode

- "External" operation mode:
This is the operation mode of the Matchbox after switching on the power. In the "external" operating mode, a control device must be connected to the A/D interface X3 in order for the necessary control signals to be sent to the Matchbox.

Internal

- "Internal" operation mode:
"Internal" operation mode requires that a PFC Controller or a PFG RF Generator be connected via a fiber optic cable. In the "internal" operating mode, the Matchbox can be operated manually or automatically via the PFC Controller or PFG RF unit, or remotely controlled by means of another source. Further details about Matchbox operation with the Controller can be found in Chapter 6 of the "PFC Controller" operating instructions.

CONTROL

Reflected RF power P_R

To optimize the RF power output to the plasma system, the PFM 1500 A Matchbox uses an adjustable load coil and two variable air capacitors. These compensate for impedance variations in the plasma-system process by minimizing the reflected RF power. Impedance variations can arise through, for example, temperature and pressure fluctuations, changes in the gas composition, etc. In addition, ceramic capacitors can be connected in parallel to increase the capacitance range of the air capacitors.

3.3 OVERVIEW OF THE DEVICE

The PFM 1500 A Matchbox is a single unit which is designed to be mounted directly to systems producing varying RF loads. Figure 3.1 shows the front side of the Matchbox. The connection to the plasma and thin-film process system is by means of a socket installed at the front.

Front view

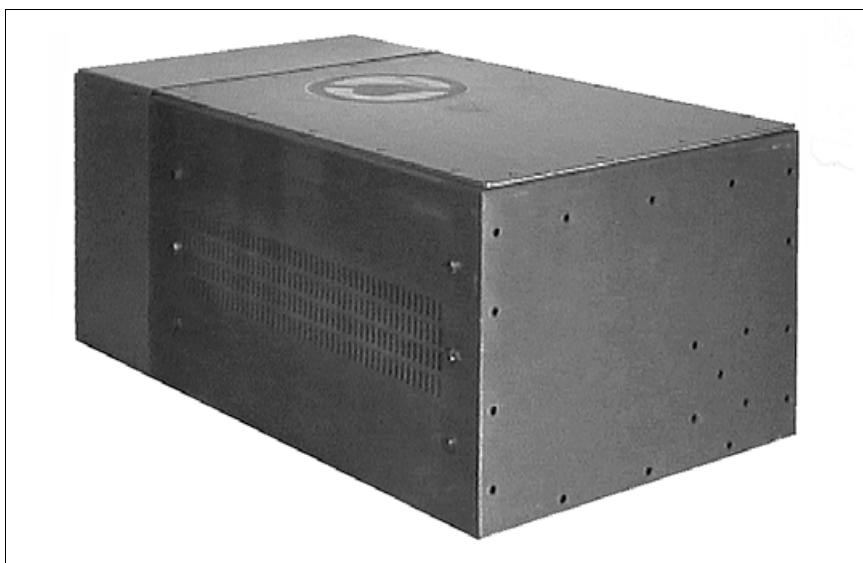


Fig. 3.1 Matchbox PFM 1500 A, front view

Rear view

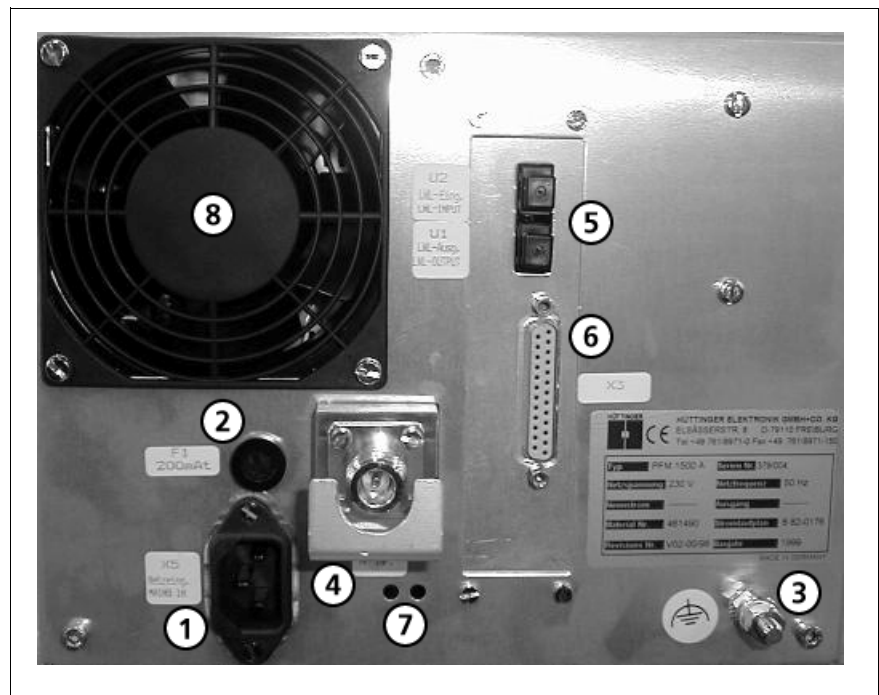


Fig. 3.2 PFM 1500 A Matchbox, rear view

The following connections are located on the rear of the Matchbox:

1. Mains voltage
2. Miniature fuse
3. Ground connection
4. RF input with securing bar
5. Fiber optic cable connectors (in and out)
6. A/D interface, 25-pin Sub-D connector
7. Manual trimming of the magnitude and phase detector
8. Ventilation

3.4 FIELDS OF APPLICATION

TYPICAL FIELDS OF APPLICATION

Plasma and thin-film processes

The PFM 1500 A Matchbox is designed as an active impedance matching device for use with plasma systems. Typical fields of application are:

- magnetron-sputtering,
- sputter-etching,
- reactive ion etching,
- CVD plasma processes,
- RF bias applications.
- inductive plasma excitation,
- induction heating.

ADAPTABILITY

Adapting to different process requirements

The PFM 1500 A Matchbox is optimally suited for plasma and thin-film processes due to its ability to perform impedance matching for a wide range of applications. In particular, Matchboxes are specifically designed to conveniently handle impedance variations due to changes in process temperature, pressure and gas composition.

When using a PFC Controller, up to 10 Matchboxes can be controlled and monitored from a single Controller. The Controller can also be used for analyzing and recording process data by connecting it to a PC.

3.5 TECHNICAL DATA

TECHNICAL SPECIFICATIONS

Technical data

PFM 1500 A	B 82-0176-00.S	B 82-0221-00.S	B 82-0226-00.S
Item No.	461490	461746	461765
RF power			
Nominal RF power	1000 W		
Frequency	13.56 MHz		
Load current (see Chap. 4)	max. 18 A rms		max. 22 A rms
Load voltage	max. 2 kVs		
Input impedance	50 Ω, coaxial socket, type N		
Mains connection			
Mains voltage	230 V	115 V	230 V
Mains voltage tolerance	-15% / +10%		
Mains frequency	50 - 60 Hz		
Mains power	100 VA		
Connection	Inlet connector for non-heating appliances		
Interfaces			
Analog/digital (A/D) (for separate control)	25-pin Sub-D socket connector		
Optical data interface (LWL)	IN: TOR x 170 (Toshiba) OUT: TOT x 170 A (Toshiba)		
Cooling			
Ventilation	air cooling of capacitors and inductances		
Ambient temperature	max. 35°C		
Miscellaneous Data			
Dimensions (WxHxD)	230 x 180 x 400 mm, excluding connectors		
Weight	approx. 7.5 kg		
Housing	chromated aluminum		
Protection class	IP 21		

Tab. 3.1 Technical data

Features	• 2 variable air capacitors, 2 tuning inductive coils • Ceramic capacitor for configuration • Motor drive at capacitors
Special feature in version for inductive load	The RF power unit for the B 82-0226-00.S can be alternatively connected for three load ranges: j30 ... j60 Ω / j50 ... j170 Ω / j160 ... j600 Ω
Measuring sensor	• Adjustment magnitude and phase measurement • RF peak voltage 0 - 2040 V_s (B 82 - 0226-00.S) • DC bias voltage 0 - 2040 VDC (B 82 - 0176-00.S, - 0221-00.S)
Controller	• Microcontroller for motor control and • automatic tuning and fiber optic cable data transmission
Operation	• via control panel on PFG RF generator • via separate PFC Controller
Regulations	• CE-conforming • Interference protection and EMC in accordance with - EN 55011 Group 2 Class A - EN 50082 Part 2 and IEC 1000-4 -2, -3, -4, -5. • Low-voltage directives 73/23/EEC for internal wiring • Power unit VDE 0110, 0160

INSTALLATION SITE

Environmental conditions	The PFM 1500 A Matchbox is mounted directly to the vacuum chamber of the plasma system. The location should be free from excessive dust or humidity and have a suitable ambient temperature (see Table 3.1).
Space requirement	In order to establish the supply connections and to allow for later service and maintenance work, the following minimum spacing should be kept around the system: • 20 cm at the rear of the Matchbox for installation and removal. • Enough space behind the device so that the RF power cable can be connected to the RF input. • The Matchboxes should never interfere with any required safety functions of the plasma system, escape routes or any other local regulations concerning safety.

4 VERSIONS, ACCESSORIES

Chapter Outline:

Who is this chapter directed at?

This chapter is intended for all persons who install and operate special variants of the basic model of the PFM 1500 A Matchboxes or accessories for them.

Chapter contents

The chapter contains information about the functionality and technology of model variants and accessories of the PFM 1500 A Matchboxes, their use, fields of application, and technical data.

4.1 RF OUTPUTS

The Matchbox for capacitive load comes with various coaxial output sockets. Please note that the full current load of 18A rms is permitted for the 13/30 socket only.



Fig. 4.1 13/30 chassis socket

For the model equipped with the 7/16 chassis socket, the maximum permissible RF output current is 12 A rms.



Fig. 4.2 7/16 chassis socket

For the model equipped with the N socket, the maximum permissible RF output current is 6 A rms.

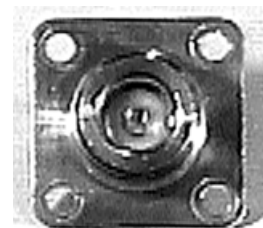


Fig. 4.3 "N" chassis socket

The standard Matchbox for inductive load is fitted with an M6 threaded neck on a ceramic insulator (bushing insulator, see Fig. 4.4).

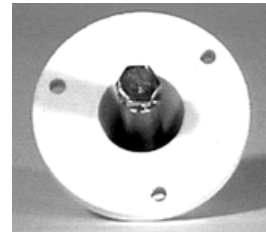


Fig. 4.4 Bushing insulator

4.2 FIBER OPTIC CABLE

The standard length range for the fiber optic cable is 0.5 ... 15 m. However, devices for the ranges 15 ... 30 m and 30 ... 50 m are available upon request. All members in an optical data system have to be specified for the same length range. The lengths of the fiber optic cables used have to lie within this range although the individual lengths of the fiber optic cables may vary.

On the device, the length range is marked beside the fiber optic cable connectors. Devices without information on length are specified for the standard length of 0.5 ... 15 m.



Notice!

Devices of the same model but specified for different length ranges have different item numbers.

4.3 MATCHBOX MODEL VERSIONS

Model versions

The PFM 1500 A Matchbox is available in the following model variations:

ITEM (ORDER) NO.	MAINS VOLTAGE	APPLICATION	SPECIAL FEATURE
461490 (B 82-0176-00.S)	230 V	capacitive load	- (basic version)
461746 (B 82-0221-00.S)	115 V	capacitive load	- (basic version)
461765 (B 82-0226-00.S)	230 V	inductive load	- (basic version)
910492 (B 82-0240-00.S)	230 V	capacitive load	RF peak measurement
941164 (B 82-0253-00.S)	230 V	capacitive load	grounding switch (vacuum relay)
943440 (B 82-0254-00.S)	230 V	capacitive load	RF output 7/16 socket
944455 (B 82-0258-00.S)	230 V	capacitive load	DC RF filter
952756 (B 82-0259-00.S)	230 V	capacitive load	RF output blind plate with drilling template for "N" socket
964526 (B 82-0261-00.S)	230 V	capacitive load	tap is preset at 2¼ turns of the load coil
967318 (B 82-0176-00.S)	230 V	capacitive load	RF output 7/16 socket
1212719 (B 82-0268-00.S)	230 V	inductive load	fiber-optic inter- face for 15 ... 30 m

Tab. 4.1 Model variations

TECHNICAL DATA FOR DIFFERENT MODELS

Basic versions:

The difference between the versions 461490 (B 82-0176-00.S) and 461746 (B 82-0221-00.S) for capacitive load lies only in the voltage supply (refer to Table 4.1).

Model 461765 (B 82-0226-00.S) is designed for operating on inductive loads and therefore measures the RF peak voltage providing a 2nd control parameter and automatic tuning enabling.

Model 910492
(B 82-0240-00.S):

This Matchbox is intended for the operation on capacitive loads, the load range corresponds to the 461490 (B 82-0176-00.S) model. For an optimum operation of plasma loads without DC bias voltage output, an RF peak measuring device (0-2040 Vs) is installed. The measurement serves to enable automatic tuning and as control or limit parameter.

Model 941164
(B 82- 0253-00.S):

A grounding switch (vacuum relay) is installed in the Matchbox connecting the RF output to ground. In thin-film processes operating on several RF electrodes with capacitive (geometric) connection between each, the grounding switch makes it possible to avoid undesirable plasma effects at "turned off" electrodes.

Grounding switch: technical data

Grounding switch control:

- 9-pin Sub-D connector
- 24 V / 0.1 A; 1000 µF internal back-up capacitor
- on and off switching only under load-free conditions.

Rating:

- max. 1.4 KV rms / 11 A rms (DC - 15 MHz)

The grounding switch may be used for operational grounding only. The type of switch selected does not allow safety applications.

Model 943440
(B 82-0254-00.S):

This Matchbox corresponds to a large extent to the basic model 461490 (B 82-0176-00.S). It also features the standard RF output as 7/16 socket; and also four M5 screw threads for attaching the Matchbox to a chassis. For the model with 7/16 chassis socket, the maximum permissible RF output current is 12 A rms.

The dimensions are indicated in the drawing B 82- 0254-00.Y.

Model 944455
(B 82-0258-00.S):

In order to connect additional DC power to an electrode, a DC/RF superposition filter is attached to this Matchbox. The filter superposes DC and RF at the load side and filters the RF voltage off the DC input. DC and RF can be supplied to the load electrode individually or together. Furthermore, there are decoupling diodes preventing the return of the DC bias voltage (RF operation) to the DC supply device.

Technical data DC/RF filter

DC input:

- coaxial socket type 7/16

load rating:

- max. 6.25 A / 1000 V DC

The DC supply voltage must have a negative polarization against GND.

Model 952756
(B 82-0259-00.S):

This Matchbox corresponds to a large extent to the basic model 461490 (B 82-0176). Instead of the RF output, a blind plate with drilling template for an "N" chassis socket is mounted. The user can therefore either directly screw the Matchbox to the plasma system or mount an N socket on the Matchbox.

Model 964526
(B 82-0261-00.S):

This Matchbox corresponds to a large extent to the basic model 461490 (B 82-0176). The RF output is of the 7/16 chassis socket type. The tap is preset at $2\frac{1}{4}$ turns of the load coil. For the model with 7/16 chassis socket, the maximum permissible RF output current is 12 A rms.

Model 967318
(B 82-0176-00.S):

This Matchbox corresponds to a large extent to the basic model 461490 (B 82-0176). The RF output is of the 7/16 chassis socket type. For the model with 7/16 chassis socket, the maximum permissible RF output current is 12 A rms.

Model 1212719
(B 82-0268-00.S)

This matchbox corresponds to a large extent to the model 461765 (B 82-0226-00.S) for inductive loads. However, the fiber-optic interface here is designed for the length range of 15 ... 30 m. The dimensions of the RF output are shown in drawing B 82-0268-00.y.

5 INSTALLATION

Chapter Outline:

Who is this chapter directed at?

This chapter is intended for all persons who install PFM 1500 A Matchboxes on the basis of this operating manual.

Chapter contents

The chapter contains advice regarding the correct mechanical and electrical installation of the PFM 1500 A Matchboxes.

5.1 TRANSPORT, STORAGE

GENERAL NOTICES

After receiving the equipment:



Check the device immediately as soon as it is delivered for completeness in accordance with the delivery note and also for visible damages incurred during transport.



Report any damages incurred during transport immediately in writing to the forwarding agency, the insurance company, and HÜTTINGER.

TRANSPORTATION

Individually packed

The Matchbox is delivered in appropriate packaging such that it reaches its destination without damage.



The device should be protected against collision and jarring at all times. Always transport the device in its original packaging.



Attention !

Transporting and storing the device under inappropriate conditions may cause permanent damage. Such damage might not be detectable from the outside. Hüttinger accepts no liability for consequential damages to the device or any other connected equipment due to improper handling.

STORAGE

The PFM 1500 A Matchbox must be stored in the original packaging under the following environmental conditions:

Environmental conditions

- Temperature range: 5°C ... 40°C
- Air humidity range: 20 % ... 80 %

5.2

POSITIONING

REMOVING THE DEVICE FROM ITS PACKAGING



Attention !

The PFM 1500 A Matchbox contains sensitive components and must be handled carefully.

The PFM 1500 A Matchbox is delivered in a special packaging.



While unpacking the PFM 1500 A Matchbox, carefully check for any visible damage. Pay particular attention to:

- damage to the housing
- damage to the interfaces



Place the shipping box on a flat surface.



Open the box and pull all four flaps open



Remove the test certificate

**Notice !**

*If there is no test certificate:
Check to see if the lid to the inner Styrofoam box is located on this side.
If it is not, then the box is upside down. Close the flaps, secure with tape and carefully turn the box over and open the other side.*



Lift out the lid of the inner Styrofoam box.



Remove the two fiber optic cables.



Replace the Styrofoam lid



While holding down one of the box flaps on a long side, carefully turn the box onto the side with the folded back flap.



While holding the other three flaps open, turn the box the rest of the way onto its top (no flaps should be under the box).



Lift the cardboard box off the inner Styrofoam box and set aside



The Styrofoam inner box should now be upside down with the lid on the bottom



Carefully lift off the Styrofoam box leaving the Matchbox up side down on top of the lid



Carefully turn the Matchbox over on the lid so that it is right side up



Check that the information on the nameplate matches that on the shipping note and your order.

PACKAGING MATERIAL***What should be kept***

The following packaging material should be kept for possible future transport:

- inner polyethylene packaging container
- shipping carton

Disposal

Any remaining packaging material should be disposed of properly. The following materials are used depending on the method of transport:

- Polyethylene (PE) for the protection of the equipment
- corrugated cardboard for internal and external packaging

All packaging materials must be disposed off according to the applicable regulations of the delivery area.

5.3

MOUNTING



Danger: high frequency !

Alternating electromagnetic fields can have an undesired, damaging effect on active and passive medical devices (pacemakers, implants...). Persons wearing active and passive medical devices must stay outside of areas affected by the Matchbox.

Due to the intensity of the electromagnetic field, magnetic materials can heat up and possibly melt.



Use a Matchbox with coaxial RF output or install the Matchbox together with a metal housing fabricated by the user. The housing serves to shield the area between the Matchbox and application.

Four internal screw threads are provided in the Matchbox housing for installation purposes. The hole dimensions can be found in the Appendix.



Use only nonmagnetic materials (brass, stainless steel, copper) for mounting the Matchbox and for attaching other devices to it.

5.4 COIL MATCHING FOR THE INDUCTIVE MATCH-BOX

The magnetic field generated by the coil of your application can excite a plasma or heat up a metallic work piece. In addition, there are various coils with different inductances and different reactances. The PFM 1500 A Matchbox must be adjusted to each coil type.

 *Refer to the technical data of your coil and compare these data to those listed in Table 5.1.*

Your coil type belongs to one of the three categories:

- Low-Z,
- Medium-Z,
- High-Z,

to which the Matchbox must then be adjusted.

OUTPUT IMPEDANCE	LOW-Z	MEDIUM-Z	HIGH-Z
Load range	j30 ... j60 Ω	j50 ... j170 Ω	j160 ... j600 Ω
equivalent to approx. μH	0.35 ... 0.7 μH	0.6 ... 2 μH	1.9 ... 7 μH
max. load current	22 A rms	15 A rms	8 A rms
max. load voltage	1.4 kV rms		

Tab. 5.1 Technical data for coil matching

 *If you perform coil matching after the first installation:*

- Make sure that the RF supply is switched off!
- Disconnect the mains power.
- As a precaution, discharge the RF input and output of the network with a grounding rod.

 *Open the cover of the Matchbox RF section with a suitable screwdriver.*



Notice !

Coil L1, capacitor C8 and the copper connection strap W5 are labeled in the Matchbox and in the circuit diagram (see Appendix).

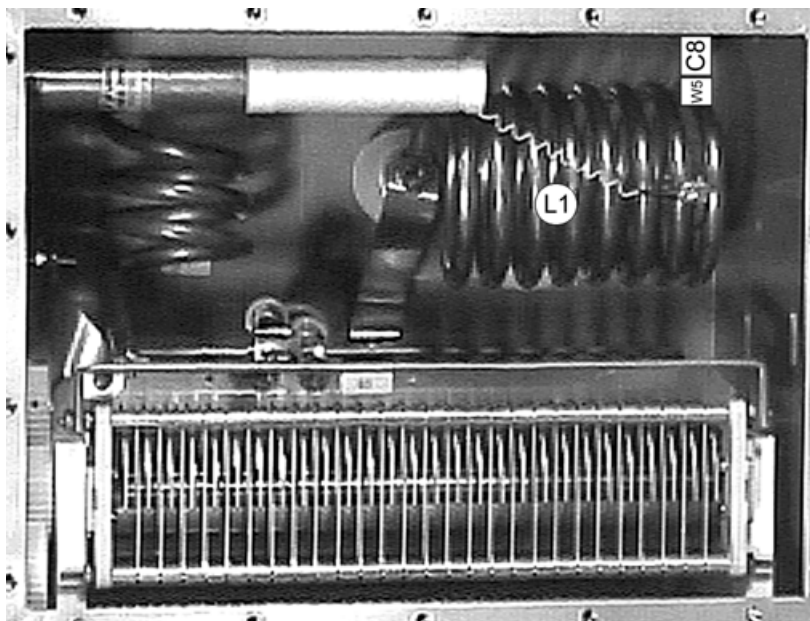


Fig. 5.1 Position of L1, C8 and W5



Perform one of the following adjustments:

High-Z

The Matchbox is delivered in the High-Z state. If you would like to set the High-Z state:



Install coil L1 and connect it as specified in the circuit diagram.



Capacitor C8 is **not** connected. The copper connection strap W5 is disconnected or removed.

Medium-Z



Remove coil L1.



Do **not** connect capacitor C8, i.e. disconnect and remove copper connection strap W5.

Low-Z



Remove coil L1.



Connect capacitor C8 with the copper connection strap W5.

5.5 CONNECTION

SAFETY



Life-threatening voltages!

The PFM 1500 A Matchbox is connected to 230 V mains voltage (or 115 V in the USA). Observe the applicable safety precautions for working with mains power.

Qualified personnel

The electrical connection of PFM 1500 A Matchboxes may only be carried out by personnel who are qualified and trained for work with electrical equipment and the Matchbox. These personnel must be accustomed with and abide by the relevant safety regulations of the installation site for the erection of electrical equipment.



Danger !

The following dangers can arise due to improper installation of the Matchboxes:

- danger of fire
- danger to life due to the high voltages

CONNECTION OF THE CONTROL CIRCUITS

Ground connection

If necessary, establish a ground connection between the Matchbox, your application and the RF generator via the grounding terminal at the rear of the Matchbox.



Connect the Matchbox to the grounding bar of your application with a suitable cable.

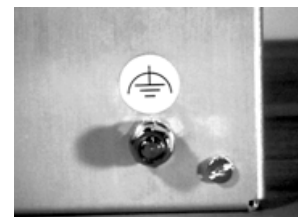


Fig. 5.2 Ground connection

Analog/digital interface

For external control purposes the Matchbox is connected to the RF power generator via the analog/digital interface X3.



If necessary, connect the control cable with the 25-pin Sub-D connector to the Matchbox.



Fig. 5.3 A/D interface X3

Optical data interface

The PFM 1500 A Matchbox is provided with two fiber optic cable interfaces through which up to ten Matchboxes can be connected to a PFC Controller.



To connect the PFC Controller, carefully remove the protective covers of connections U1 and U2 on the Controller and Matchbox. Insert the fiber optic cable connector. Connect the output of the Matchbox (Matchbox U1) to the input of the Controller (Controller U2) and the Controller output (U1) to the Matchbox input (U2).

Proceed as described above if you would like to control the Matchbox from a PFG RF series generator.



If more than one Matchbox are to be connected in series to the Controller, connect the Controller output (U1) to the input of the first Matchbox (U2 Matchbox 1), then the output of the first Matchbox (U1) to the input of the second Matchbox (U2 Matchbox 2), etc., up to ten Matchboxes. Finally, connect the output of the last Matchbox (U1) to the input of the Controller (Controller U2). The fiber optic circuit must make a complete loop through all Matchboxes for it to work properly.

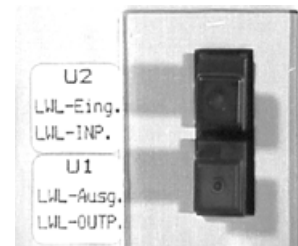


Fig. 5.4 Fiber optic cable interface



Notice!

Please note that all connected members have to be adjusted to the same length range of the transmission line.

The length of the fiber optic cable used has to correspond to this range.

MAKING THE ELECTRICAL CONNECTIONS

Making the RF connection



Remove the securing bar from the RF input.



Connect the RF generator cable to the RF input X1 (socket-type N) of the Matchbox.



Mount the securing bar to the RF input to prevent the RF connector from (accidentally) loosening without tools.



Fig. 5.5 RF input X1, securing bar removed

Make the connection to the DC input

Only for devices with DC/RF superposition filter:

-  *Remove the securing bar from the DC input.*
-  *Connect the cable of the DC supply unit to the socket marked "DC input" (type 7/16) of the DC RF filter (housing mounted on top of the Matchbox).*
-  *Mount the securing bar to the DC input to prevent the DC connector from (accidentally) loosening without tools.*
-  *Make sure that the RF and DC cables are connected to the same side as the corresponding supply units.*



Danger!

If a Matchbox with DC RF superposition filter is powered by a DC or RF generator, both input cables (DC and RF) have to be connected at all times and coupled with the corresponding supply unit, the connectors have to be locked with the securing bar.

Output connection (version for inductive load)

-  *Connect the connector of your application to the RF output of the Matchbox.*

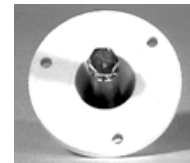


Fig. 5.6 Bushing insulator

The standard RF output is installed in the factory as a bushing insulator with M6 threaded neck. The connection to the application can be made, for example, with flat copper 20 x 0.5 mm or copper tubing Ø 8 mm. The length of the connection should be less than 20 cm. If you require another RF output socket, read Chapter 4.1: "RF outputs".

The connection between the Matchbox output and the application must be completely shielded with metal. To accomplish this, the Matchbox must be bolted to the shield housing of the application at several locations. If this is not possible, place a connection housing between the Matchbox and the application.

Both the Matchbox housing and the shield housing of the application must be tightly connected to the connection housing in several places.

Output connection with coaxial socket

If your Matchbox is equipped with a coaxial socket as RF output (e.g. 7/16 chassis socket), proceed as follows:

-  *Remove the securing bar from the RF output.*
-  *Connect the application RF cable to the RF output socket of the Matchbox.*
-  *Mount the securing bar to the RF output of the Matchbox to prevent the RF connector from (accidentally) loosening without tools.*

Connection RF current return path

For applications which are integrated into a shield housing, the return path of the RF current is via the inside of the application's shield housing, the inside of the connection housing to the inside of the Matchbox.

Examples of this are plasma-sputtering cathodes or plasma-etching devices. (See Fig. 5.7, 5.8 and 5.9). The "RF output ground return" connection is, in this case, not used.

Applications that require a ground return are connected directly to the connector "RF output ground return".

Examples of this are inductive coils for inductive heating or inductive plasma excitation. (See Fig. 5.10)

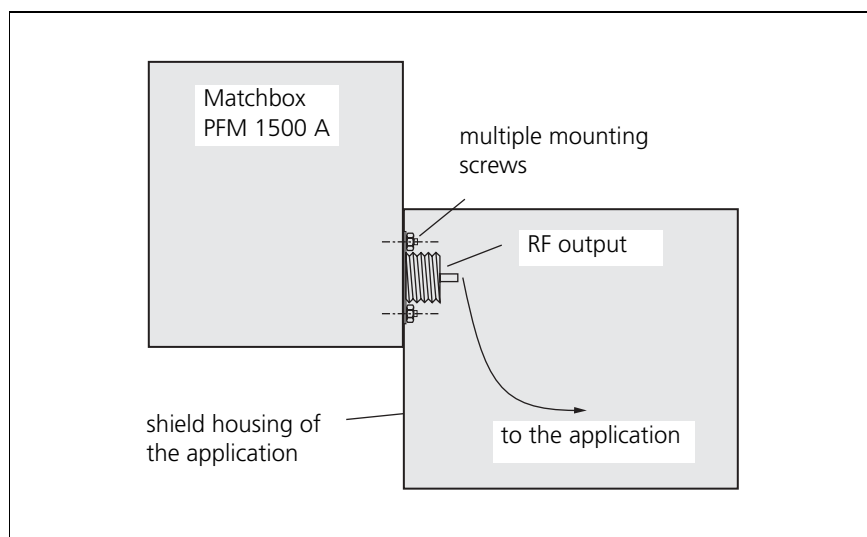


Fig. 5.7 Ground return via the shield housing

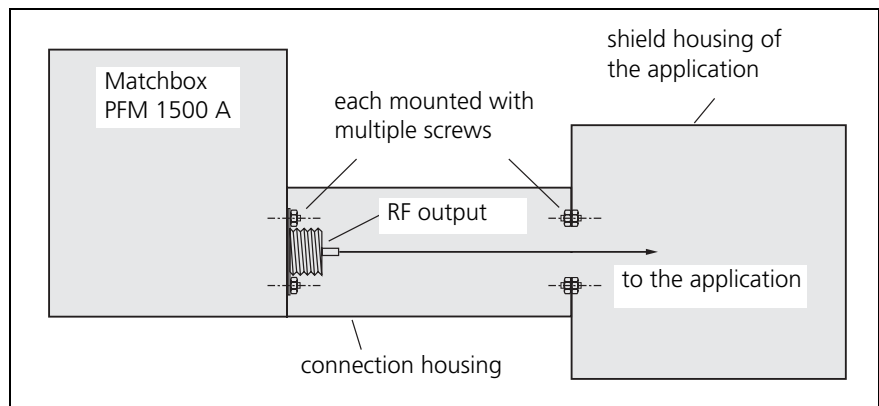


Fig. 5.8 Ground return via the shielded and connection housing

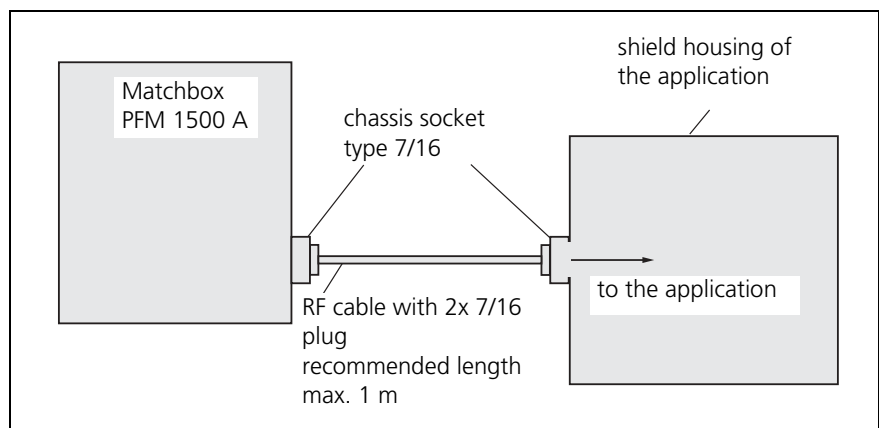


Fig. 5.9 Ground return via the RF cable

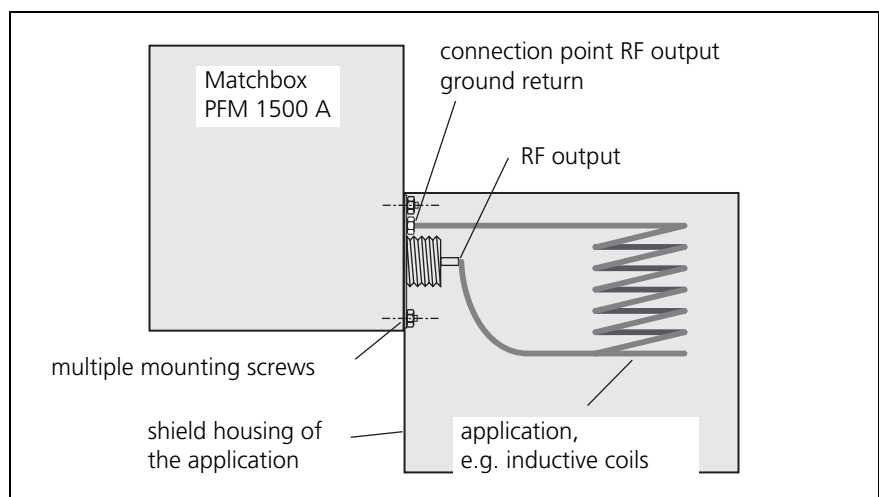


Fig. 5.10 Ground return via the connection point

**Danger !**

In order to ensure protection against electrical shock and electromagnetic fields, the connection between the Matchbox and the application must be carried out as described. Bringing a high-frequency system into operation whose application has not been connected as described above can lead to the following dangers:

- Electrical shock and / or burns when touching uncovered parts.
- Exposure to electromagnetic fields.
- Faulty functioning or damage to other devices due to electromagnetic fields.

Contact Hüttinger with any questions concerning use of your application.

**Notice !**

According to DIN EN 61010-1 / VDE 0411 Part 1, a mains separation device must be installed in the electrical supply of the PFM 1500 A Matchbox.

This has to be:

- designed as a switch or power switch,
- installed near the RF generator and easily accessible by the user,
- labeled as a separation device for the Matchbox.

**Life-threatening voltages !**

As soon as the mains cable is connected, voltage is immediately present in the Matchbox.



Never open the housing when the Matchbox is connected to the voltage supply.



Check whether the mains voltage indicated on the nameplate of the Matchbox corresponds to the mains voltage available at the installation site. Contact HÜTTINGER Service if the supply voltage is different.

Mains connection

- Connect the mains cable with the inlet connector for non-heating appliances to the Matchbox.
- Connect the socket end of the cable to the device and plug the other end into a mains socket.

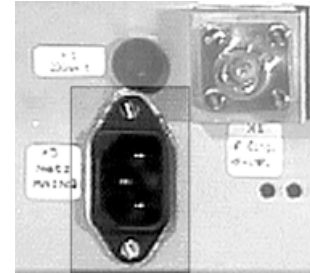


Fig.5.11 Mains connection

If you want to use a mains cable different from the one included in the delivery or if you want to mount a different mains connector on the cable that comes with the Matchbox:

- Check whether the resistance between Matchbox housing and PE connection of the mains plug is within the limits set by the regulations valid for the installation site.

This work may be performed by trained and qualified personnel only.

After all electrical connections have been made:

Checking electrical connections

- Check all connectors and cables for a stable connection.
- Check the functioning of the servo drives using the Controller.

5.6

DISMANTLING, PACKING

REMOVE CONNECTIONS

- Please make sure that the RF power and any other supply units which may be connected are switched off!
- Disconnect the mains power.
- Disconnect the RF power cables from the front and the rear of the Matchbox.
- Disconnect the fiber optic communication cables.
- Remove the connector at the analog/digital interface.



Life-threatening voltages !

Even after switching off and disconnecting the mains, residual voltages can be present in the Matchbox.



Observe the safety information in Chapter 2: "Safety".

PACKAGING



Pack the Matchbox either in its original packaging or another appropriate packaging which will protect it from humidity and jarring.

DISPOSAL

Materials

Old pieces of equipment that have no further use must be specially disposed of. The Matchbox consists of the following materials:

- Metals
 - aluminum
 - copper
 - steel
 - brass
 - sheet iron
 - galvanized sheet steel
- Plastics
 - Teflon
 - PA and others
- Other
 - cardboard, ceramic
 - printed circuit boards, mounted with electronic components



6

OPERATION, CONTROL

Chapter Outline:

Who is this chapter directed at?

This chapter is intended for all persons who operate PFM 1500 A Matchboxes on the basis of this operating manual.

Chapter contents

The chapter contains a description of the modes and states of operation as well as operating instructions for PFM 1500 A Matchboxes.

6.1

MATCHBOX OPERATION

SAFETY INSPECTION

Before operating the Matchbox, check all RF cables for a stable connection.

PREPARING FOR OPERATION

Switch on the external mains separator.

The A/D interface is activated and the Matchbox is in "external" operation mode.

With water-cooled devices:



Switch on the cooling water supply.

The Matchbox is now ready for power operation.

POWER OPERATION

 *Switch on RF power.*

The equipment is now in power operation. The capacitor settings of the Matchbox and hence the reflected RF power are controlled either by the PFG RF Generator or the PFC Controller.

SWITCHING OFF THE MATCHBOX

Make sure that all RF sources are deactivated.

 *Switch off the external mains separator.*

SWITCHING OFF IN AN EMERGENCY

 *Carry out the emergency measures for the equipment to which the Matchbox is connected.*



Life-threatening voltages !

Even after switching off, the Matchbox still may contain residual voltage.

6.2

OPERATION MODES

"EXTERNAL" OPERATION MODE

In external operation mode, a control device must be connected to the Matchbox at interface X3 (see Chapter 8, "Interfaces") that will provide the required control signals. After switching on the power, the Matchbox is automatically in "external" operation mode.

The operation mode can be changed to "Internal" operation mode using menu functions of the optional PFC Controller.

"INTERNAL" OPERATION MODE

If the Matchbox is to be controlled using a PFC Controller:



Connect the PFC Controller to the Matchbox. (see Chapter 5 of the PFC Controller operating instructions)

This has the following consequences:

- The Matchbox can be controlled either with the Controller or from the interface X3, depending on the selected mode of the Controller (see Chapter 6 of the PFC Controller operating Manual).
- Actual values of the Matchbox parameters can be monitored at the Controller.

6.3

TROUBLESHOOTING, RECTIFICATION OF FAILURES

INDICATIONS OF FAILURE

On the Controller

There are no external indicators on the Matchbox for the operating status of the device.

Failure of the Matchbox is indicated by a HIGH state at pin 16 of the X3 interface (see Chapter 8: "Interfaces").

The following table describes various conditions which lead to a "failure" state of the Matchbox and the necessary steps to correct the problem.

SYMPTOM	CAUSE	REMEDY
Matchbox cannot be accessed via the Controller.	Fuse F1 blown	Replace the blown fuse.
	Improper connection of the fiber optic cables.	Correct the connection. Check that the fiber optic cable is not damaged, kinked or squeezed.
	Matchbox and Controller (or another optical data ring member) are not specified for the same length range.	Please use matching components.
	The length of the fiber optic cable does not correspond to the length range in the marking.	

Tab. 6.1 Error messages

RECTIFICATION OF FAILURES

If the cause of a failure cannot be located or corrected:



Call HÜTTINGER Service.

7 MAINTENANCE

Chapter Outline:

Who is this chapter directed at?

This chapter is intended for all persons who maintain PFM 1500 A Matchboxes on the basis of this operating manual.

Chapter contents

The chapter contains advice regarding the regular maintenance and care of the PFM 1500 A Matchboxes.

7.1 GENERAL MAINTENANCE NOTICES

There are no user serviceable parts inside the PFM 1500 A Matchbox and the PFC Controller.



Notice !

Maintenance work should only be carried out by HÜTTINGER service personnel and specially trained technicians. Qualified personnel should refer to the service manual for information concerning maintenance and repair.

TECHNICAL SUPPORT

Service personnel from Hüttinger can be reached via the Hüttinger head office.

7.2 IGNITION SETTING

To ignite the gas discharge in the plasma chamber, C_T and C_L must be set on the Controller. Proceed as follows:

-  *Connect your application to the system.*
-  *Set an RF output power between 5% and 20%.*
-  *Set the operation mode on the Controller to "Manual".*
-  *Set the C_T on the Controller display to a value between 800 and 1000.*
-  *Set C_L to 0.*
-  *Start up the system.*
-  *Slowly adjust the value of C_L from 0 to 1000.*
-  *Observe at which C_L value the plasma ignites and leave C_L at this setting.*

The value for C_L should be greater than 500.



Life-threatening voltages !

If the value of C_L is very small (< 150), a very high voltage may be present at the RF output. There is a risk of flashover!



Notice !

If you have passed through the entire C_L value range and no gas discharge was observed or if the value of C_L is smaller than 500, please carry out the adjustment instructions in Chapter 7.4: "Changing the tap on the load coil" now. Afterwards, begin the ignition setting again.

Tuning

A good "plasma-on" position means maintaining the lowest possible reflected power P_R . If P_R is less than 5% (with reference to P_I), acceptable tuning has been achieved. Proper tuning is achieved, if P_R is less than 1% of P_I .

-  *Alternately make small adjustments to the settings for C_L and C_T . Read the Controller display to determine with which setting the lowest reflected power P_R is achieved.*



Notice !

If the tuning behavior (matching) is very sharp, i.e. a slight change in the value of C_L or C_T results in a disproportionately large change in the value of P_R , please install additional ceramic capacitors in the Matchbox as described in Chapter 7.3: "Increasing the capacitance".

The ignition maximum can also be exactly determined with the aid of an oscilloscope and a probe:

Ignition setting with the aid of an oscilloscope



Set the deflection on the oscilloscope to approx. 1 ms/div.



Hold the tip of the probe in the shield housing made by the system operator (without making physical contact!),

or



Hold the probe close to your application (without making physical contact!).



Set the sensitivity of the oscilloscope so that the measured (very small) RF voltage is displayed as a band on the screen (and not as an individual sinusoidal oscillation).



Alternately make small adjustments to the settings for C_L and C_T on the Controller. Read the oscilloscope screen to determine at which setting the band is widest. This setting indicates the ignition maximum.

Teach-in Plasma-on

You carried out plasma ignition and successful tuning in the "Manual" operation mode. To save the set values of C_T and C_L as a "plasma-on" position, you must first switch the Matchbox to the "Automatic" operation mode as in the previously described setting ($P_R < 5\% P_i$; DC bias or RF peak $> 5V$).

The previously determined values of the ignition position for C_T and C_L should subsequently be set on the Controller. This can be carried out with the power switched either off or on.

Function description "Automatic tuning"

The Matchbox is switched to "Automatic" with the Controller. With the RF power switched off, the Matchbox returns to the set ignition positions of C_T and C_L . The criterion for setting the ignition position is: DC bias voltage and RF peak voltage < 5V. If the DC bias voltage (or RF peak voltage) > 5V condition is fulfilled, the Matchbox moves the capacitors C_T and C_L to the previously stored (teach-in) "plasma-on" position. Once C_T and C_L have reached the "plasma-on" position, the automatic matching is activated with the measured values of the magnitude/phase detectors. In the operation mode DC AUTO, only the DC bias voltage is queried as an enable criterion. In this way, the best possible matching is ensured, even under changing load conditions.



Notice !

The "plasma-on" positions stored under "teach-in" are not displayed. To change these, the procedure is to be completed again as described.

The function "plasma-on position teach-in" is not available with Controller PFC 100 M.

7.3

INCREASING THE CAPACITANCE

As the set values C_T and C_L for matching are dependent on the load, it may be necessary to increase the capacitance C_L of the Matchbox. Also, in the case of an excessively sharp tuning behavior (see Chapter 7.2: "Ignition setting"), please carry out the following modification to the Matchbox.



Life-threatening voltages !

The following steps should only be carried out by qualified personnel trained to work with electrical equipment who have read and understood all safety instructions in this manual.



Switch off the complete system including RF generator, Matchbox and Controller.



As a precaution, discharge the RF inputs and outputs of the Matchbox with a grounding hook.



Open the housing cover of the RF part of the Matchbox with a suitable screwdriver.

The following components will be visible:

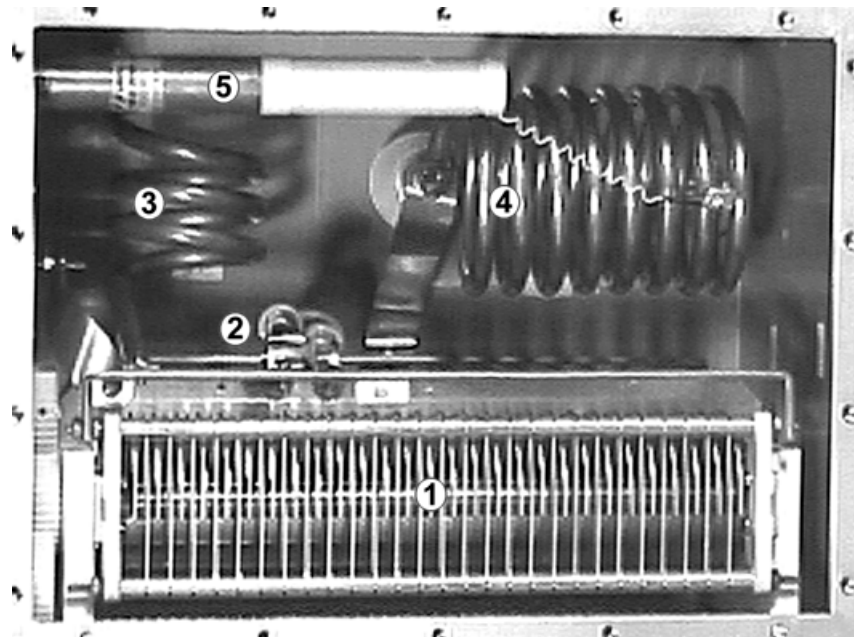


Fig. 7.1 PFM 1500 A Matchbox, opened

1. Two variable air capacitors one behind the other (front: C_T)
2. Parallel additional capacitors
3. Tuning coil
4. Load coil with variable tap (with capacitive load), or coil L1 (in versions for inductive load).
5. DC-bias voltage measurement parallel to RF output (or RF peak voltage measurement in versions for inductive load)

With matching networks for capacitive loads, 3 ceramic capacitors are included in the scope of delivery. These can be wired in parallel with the air capacitor C_L .

Holes are provided on the side for installation purposes.



Fig. 7.2 Ceramic capacitors

➤ Connect one to three ceramic capacitors in parallel with the C_L air capacitor in order to increase the capacitance.

➤ Close the Matchbox and reconnect it to your system.

➤ Carry out the ignition setting described in Chapter 7.2: "Ignition setting".



Fig. 7.3 Installing the ceramic capacitors

7.4

CHANGING THE TAP ON THE LOAD COIL

If you are unable to ignite the plasma or if the value for C_L after matching is below 500, please carry out the following instructions:



Life-threatening voltages !

The following steps should only be carried out by personnel trained to work with electrical equipment who have read and understood all safety instructions in this manual.

-  *Switch off the complete system including RF Generator, Matchbox and Controller.*
-  *As a precaution, discharge the RF inputs and outputs of the Matchbox with a grounding hook.*
-  *Open the housing cover of the Matchbox.*
-  *Move the tap on the load coil by pushing the clamp.*

If you set the clamp to a relatively small number of turns towards the RF output, the value of C_L is increased. The value changes by approx. 150 with each turn.



Fig. 7.4 Load-coil clamp

-  *Close the Matchbox and reconnect it to your system.*
-  *Carry out the ignition setting as described in Chapter 7.2: "Ignition setting".*

7.5

MEASUREMENT VALUE ADJUSTMENT

Adjusting magnitude and phase

If the reflected power P_R in automatic operation should move outside of the acceptable limit values and you are unable to bring about an improvement with the previous settings (Chapter 7.2 through Chapter 7.4), a screwdriver can be used on the adjustment potentiometer to carry out a measured-value adjustment for magnitude (Z) and phase (j). Z and j are displayed on the Controller.

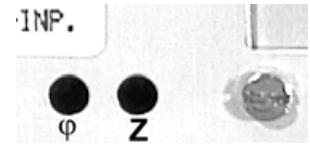


Fig. 7.5 Access openings for trimming potentiometer



Contact HÜTTINGER before carrying out the adjustment.

8 INTERFACES

Chapter Outline:

Who is this chapter directed at?

This chapter is intended for all persons who operate PFM 1500 A Matchboxes on the basis of this operating manual.

Chapter contents

This chapter contains detail information about the interfaces of the PFM 1500 A Matchboxes.

8.1 DESCRIPTION OF THE INTERFACES

The PFM 1500 A Matchbox has the following interface connections:

- 25-pin Sub-D device socket (X3)
- Fiber optic cable connectors
- 9-pin Sub-D connector in devices with grounding switch

A/D interface X3

PIN NO.	ASSIGNMENT
1	+ 24 V DC
2	COM IN
3	AUTO IN
4	reset/freeze
5	not used
6	C _T set value
7	C _L set value
8	PR option
9	PI option
10	C _T actual value
11	C _L actual value
12	RF peak voltage option
13	DC bias voltage option

Tab. 8.1 Pin assignments A/D interface X3

PIN NO.	ASSIGNMENT
14	ground
15	AUTO OUT
16	fault
17	not used
18	not used
19	ground
20	ground
21	ground
22	ground
23	ground
24	ground
25	ground

Tab. 8.1 Pin assignments A/D interface X3

8.2 SIGNAL DESCRIPTION OF X3

ANALOG SIGNALS

Outputs

DC bias voltage (13)

The actual value of the process voltage. (0 ... 10 V $\Rightarrow$ 0 ... 2040 V), installed in Matchboxes for capacitive loads

C_L actual value
0 ... 10 V (+) (11)
and
 C_T actual value
0 ... 10 V (+) (10)

Actual position of the load and tuning capacitors:

- 0 V equals minimum capacitance
- 10 V equals maximum capacitance

RF peak voltage

Actual value of the load voltage (peak value) 0 ... 10 V $\Rightarrow$ 0 ... 2040 V, installed in Matchboxes for inductive loads

Inputs

C_L set value
0 ... 10 V (+) (7)
and
 C_T set value
0 ... 10 V (+) (6)

Set value position of the load and tuning capacitors:

- The application of 0 ... 10 V DC causes the capacitor to tune through its entire range.
- Adjustment of the capacitor positions through this interface is only possible in the "Manual" operation mode (PFC Controller).

DIGITAL SIGNALS

Outputs

Error (16)

Error status of the Matchbox:

- HIGH = error
- LOW = no error

AUTO OUT (15)

Acknowledgment of automatic operation:

- HIGH = automatic operation
- LOW = manual operation

Inputs

RESET (4) / FREEZE (4)

Reset the Matchbox:

- HIGH = clearing of an error message
- Selection of the "External" operation mode when operating without fiber optic cable
- Blocks the C_L / C_T capacitors at their current positions as long as the HIGH signal is active; overrides all other inputs

AUTO IN (3)

Switches the Matchbox between automatic and manual operation:

- HIGH switches the Matchbox to automatic operation
- LOW = switches the Matchbox to manual operation

COM IN (2)

Digital common:

- Connect either to an external common or internal common at pin 14.

*+ 24 V (1) and
ground (14;19 - 25)*

Reference voltage for the digital output signals:

- Bridging W1 on the PCB supplies the interface with the internal +24 V DC.
- If W1 is not used, +24 V DC must be supplied externally at pin 1.

8.3 OPTICAL DATA INTERFACES

The optical data interfaces U1 and U2 are used to connect up to ten PFM 1500 A Matchboxes to one PFC Controller. The fiber optic system provides a complete data and control network. All parameter actual values for each Matchbox can be accessed. All control functions, such as setting the capacitor positions and switching between operation modes, can all be carried out from a single PFC Controller.

The Controller transmits control commands via the output U1 and receives data via the input U2. The fiber optic cable has to be connected from the Controller output U1 to the input U2 of the first Matchbox. Output U1 of the first Matchbox is connected either back to input U2 of the Controller or with input U2 of the next Matchbox (max. 10). The last Matchbox must be connected back to the Controller (U2 of the Controller).

Instead of the PFC Controller, a PFG RF series Generator can also be used to control one or more Matchboxes.

Fiber optic transmitters and receivers are designed for certain length ranges of the fiber optic cables. The length ranges of the transmitters, receivers and fiber optic cables used have to match (refer to Chapter 4: "Versions, accessories ").

8.4 GROUNDING SWITCH INTERFACE

A 9-pin Sub-D connector is mounted on the device.

PIN NO.	ASSIGNMENT
2	0V (device isolated)
3	+24 V / 0.1 A (control of the grounding switch; internally connected with 1000µF back-up capacitor)

Tab. 8.2 Pin assignment of the grounding switch interface